9 SAFE TORQUE OFF (STO) FUNCTIONALITY; NOT CERTIFIED

CONTENT

9.1 In Brief

The EPOS4 offers the Safe Torque Off (STO) safety feature based on IEC/EN 61800-5-2.

The present application note explains how to setup and configure the EPOS4 controller for the STO functionality.

Pin numbering in the diagrams shown is related to EPOS4 controllers that feature connectors.

Non-certified STO functionality
The implemented STO functionality will not be certified.

9.2 Precautionary Measures

WARNING

Risk of Injury
Operating the device without the full compliance of all relevant safety regulations and/or neglecting the basic working principle of Safe Torque Off (STO) may cause serious injuries!

- *Carry out a comprehensive and thorough risk assessment covering the entire safety system and all safety-relevant aspects to ensure that the STO function will fulfill all relevant safety requirements of the application.*
- *The STO function **does not** cut the power supply to the drive and **does not** provide electrical isolation.*
- *The STO function **can prevent** unexpected motor rotation of an electronically commutated motor (EC motor, BLDC motor, brushless DC motor) in a save manner. Even in error condition with one or more short-circuited power stage transistors, an electronically commutated motor will not be able to generate torque over a relevant rotation angle.*
- *Vice versa, the STO function **cannot prevent** unexpected motor rotation of a mechanically commutated motor (DC motor, brushed motor) in a safe manner. Despite of the STO functionality, an error condition of short-circuited power stage transistors may lead to unexpected motor rotation.*

9.3 Overview

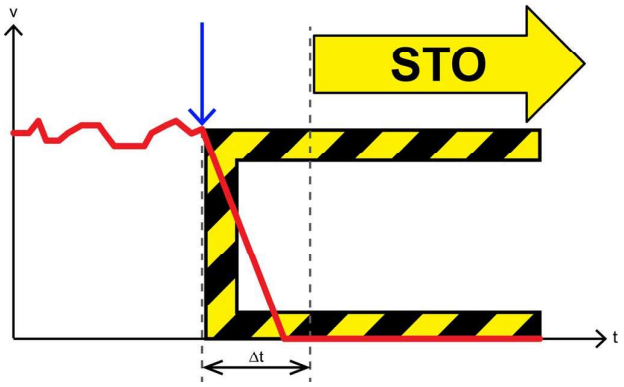

Figure 9-137 Safe Torque Off (STO) | Working principle

The STO function is the most common and basic drive-integrated safety function. It ensures that no torque-generating energy can continue to act on a motor and prevents unintentional starting.

STO has the immediate effect that the drive can no longer supply any torque-generating energy. STO can be used whenever the drive will be brought to a standstill in a sufficiently short time by load torque or friction, or if coasting down of the drive is not relevant to safety. STO enables safe working when, for example, the protective door is open (restart interlock) and has a wide range of uses in machinery with moving axes (such as handling or conveyor systems).

Mechanical brakes must be used if output shafts of motors or gearboxes are affected by forces that could trigger a movement once the motor has been shut down. Possible applications are vertical axes or motors with high inertia.

The STO function can be utilized to perform a safe stop according to IEC/EN 60204-1, stop category 0 (uncontrolled stop by immediate shut-down of the power supply to the actuators).

9.4 Functional Diagram

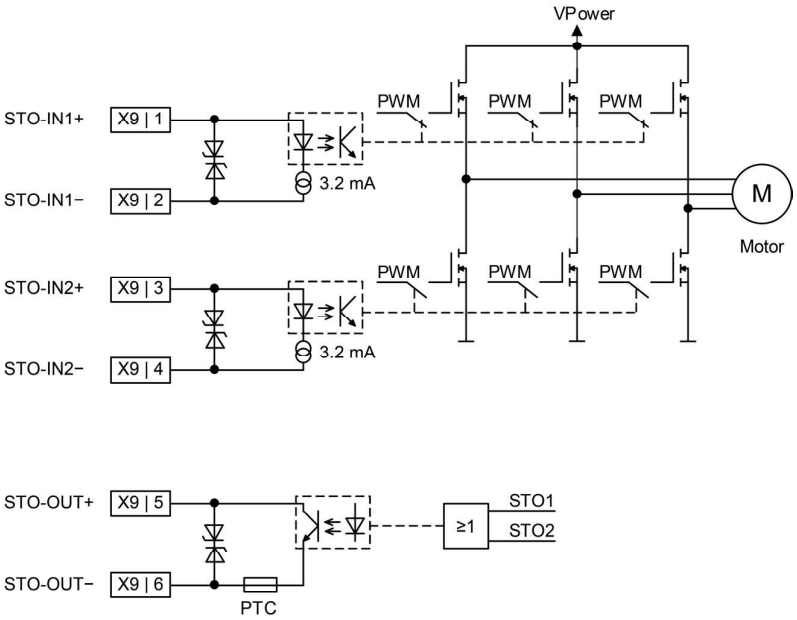

Figure 9-138 Safe Torque Off (STO) | Functional diagram

Interrupting the current to either STO1 or STO2 input will disable the drive output. Thus, the power supply to the motor is cut by stopping the switching process of the output transistors in a safe way.

The STO output is activated when either STO1 or STO2 input is powered. For details on the STO logic states ➔Table 9-87.

9.5 STO Idle Connector

In order to activate the power stage, **either** both STO inputs must be powered **or** the «STO Idle Connector» (520860) must be plugged.

Do not use the activation voltage V_{STO} (+5 VDC) for any other purpose.

The «STO Idle Connector» is included with every EPOS4 controller that features connectors.

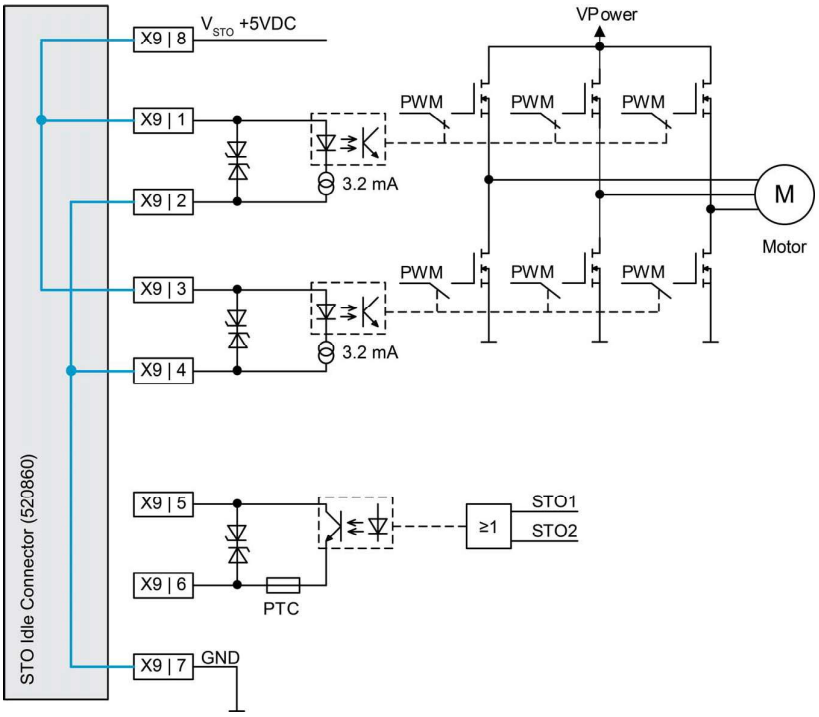

Figure 9-139 Safe Torque Off (STO) | STO Idle Connector

9.6 STO Inputs 1 & 2

9.6.1 Specifications

Safe Torque Off inputs 1…2	
Circuit type	Optically isolated input
Input voltage	0…+30 VDC
Max. input voltage	±30 VDC
Logic 0	<1.0 VDC
Logic 1	>4.5 VDC
Input current at logic 1	>2 mA @ 5 VDC typically 3.2 mA @ 24 VDC
Reaction time	<25 ms

Table 9-85 STO input specification

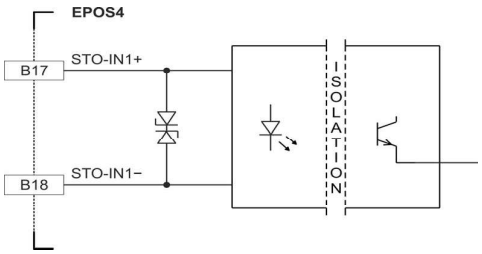

Figure 9-140 Safe Torque Off (STO) | STO-IN1 circuit (analogously valid for STO-IN2)

9.6.2 Test Pulses

The STO1 and STO2 inputs are designed for use with fail-safe output terminals with test pulses.

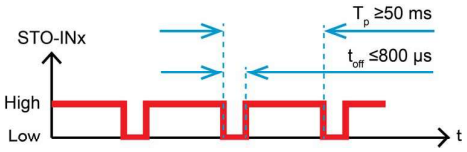

Figure 9-141 Safe Torque Off (STO) | Test pulses

Test pulses that do not fulfill the stated specifications for T_p and t_{off} can have a negative impact on the power stage gate control and can lead to unpredictable behavior.

9.6.3 Input Current

To achieve a fail-safe current measurement supervision on the output terminal, the current threshold must be lower than the typical STO input current (3.2 mA @ 24 VDC).

9.7 STO Output

9.7.1 Specifications

Safe Torque Off output	
Circuit type	Optically isolated output with self-resetting short-circuit protection
Max. input voltage	±30 VDC
Max. load current	15 mA
Leakage current	<10 µA @ +30 VDC
Max. voltage drop	1.3 V @ 2 mA 2.5 V @ 15 mA

Table 9-86 STO output specification

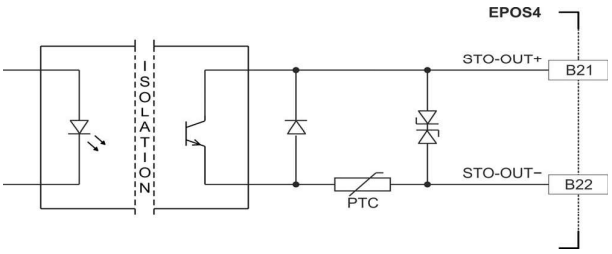

Figure 9-142 Safe Torque Off (STO) | STO-OUT circuit

9.7.2 Diagnostics

The STO output is used for proof test of the EPOS4's internal STO functionality. Thereby, the proof test must be triggered by an external logic.

Proof test is essential to reveal any dangerous, undetected failure after a given period of time.

STO logic state			
STO-IN1	**STO-IN2**	**STO-OUT**	**Power Stage**
0	0	open	inactive
1	0	closed	inactive
0	1	closed	inactive
1	1	closed	active

Table 9-87 Safe Torque Off (STO) | Logic state

For diagnostics, maintain the reaction time of <25 ms between STO input state change and the STO output state change.